Multimedia Systems
Lecture – 14

By

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CCIR and ITU-R Standards for Digital Video

- The CCIR is the *Consultative Committee for International Radio*. One of the most important standards it has produced is *CCIR-601* for component digital video.
- This standard has since become standard ITU-R Rec. 601, an international standard for professional video applications.
- It is adopted by several digital video formats, including the popular DV video.
- The NTSC version has 525 scan lines, each having 858 pixels. Because the NTSC version uses 4:2:2, each pixel can be represented with two bytes (8 bits for *Y* and 8 bits alternating between *U* and *V*). The Rec. 601 (NTSC) data rate is thus approximately 216Mbps.

- The CIF format (Common Interchange Format) was established for a progressive digital broadcast television. It consists of VHS quality resolutions whose width and height are divisible by 8—a requirement for digital encoding algorithms.
- The Quarter Common Interchange Format (QCIF) was established for digital videoconferencing over ISDN lines.
- CIF is a compromise between NTSC and PAL, in that it adopts the NTSC frame rate and half the number of active lines in PAL.
- When played on existing TV sets, NTSC TV will first need to convert the number of lines, whereas PAL TV will require frame rate conversion.

ITU-R digital video specifications

	Rec. 601 525/60 NTSC	Rec. 601 625/50 PAL/SECAM	CIF	QCIF
Luminance resolution	720 × 480	720 × 576	352 × 288	176 × 144
Chrominance resolution	360 × 480	360 × 576	176 × 144	88 × 72
Color subsampling	4:2:2	4:2:2	4:2:0	4:2:0
Aspect ratio	4:3	4:3	4:3	4:3
Fields/sec	60	50	30	30
Interlaced	Yes	Yes	No	No

High-Definition TV (HDTV)

- The usual NTSC analog TV signal in the United States has 525 scan lines, with 480 actually visible. The usual TV has an effective picture resolution of about 210,000 pixels.
- Today, consumers are accustomed to better resolutions such as 1024×768 and even higher, which are now commonly supported by most graphics hardware that come with computers.
- A class of digital television called HDTV supports a higher resolution display format along with surround sound.
- The visual formats used in HDTV are as follows:
  - 720*p*—1280×720 pixels progressive
  - 1080*i*—1920×1080 pixels interlaced
  - 1080*p*—1920×1080 pixels progressive

- They use the MPEG2-based video compression format with a 17 Mbps bandwidth.
- Although HDTV signals can be stored and transmitted effectively using MPEG-2 technology, a lot of bandwidth is required to transmit numerous channels.
- The aspect ratio of HDTV is 16:9 (1.78:1), which is closer to the ratios used in theatrical movies, typically 1.85:1 or 2.35:1.
- The increased resolution provides for a clearer, more detailed picture. In addition, progressive scan and higher frame rates result in a picture with less flicker and better rendering of fast motion.

Ultra High Definition TV (UHDTV)

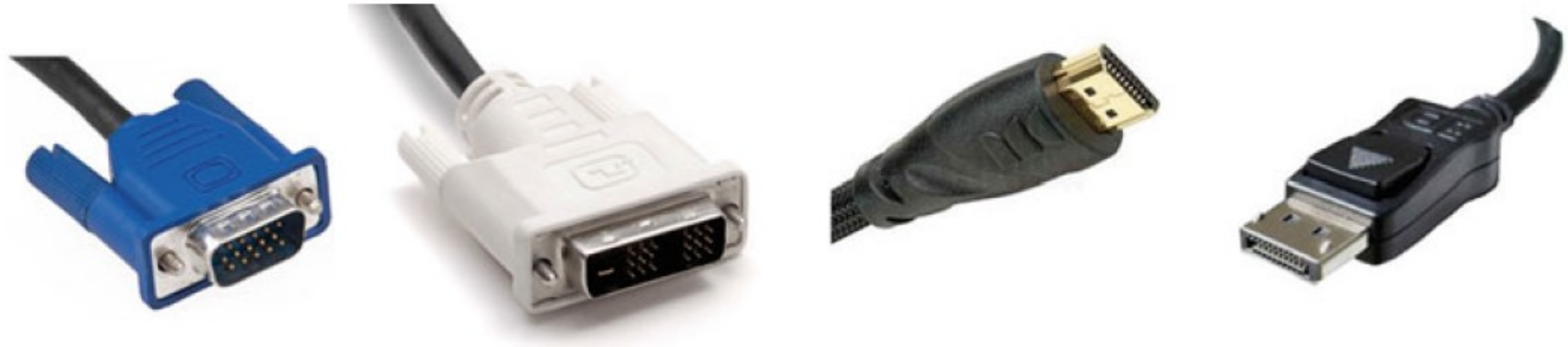
- UHDTV is a new development—a new generation of HDTV.
- The standards announced in 2012 support 4K UHDTV: 2160P (3,840×2,160, progressive scan) and 8K UHDTV: 4320P (7,680 × 4,320, progressive scan).
- The aspect ratio is 16:9. The bit-depth can be up to 12 bits, and the chroma subsampling can be 4:2:0 or 4:2:2.
- The supported frame rate has been gradually increased to 120 fps.
- The UHDTV will provide superior picture quality, comparable to IMAX movies, but it will require a much higher bandwidth and/or bitrate.

Digital Display Interfaces

- Given the rise of digital video processing and the monitors that directly accept digital video signals, there is a great demand toward video display interfaces that transmit digital video signals.

- The most widely used digital video interfaces include
  - Digital Visual Interface (DVI)
  - High- Definition Multimedia Interface (HDMI), and
  - DisplayPort

Connectors of different digital display interfaces. From left to right: VGA, DVI, HDMI, DisplayPort



Digital Visual Interface (DVI)

- Digital Visual Interface (DVI) was developed by the *Digital Display Working Group* (DDWG) for transferring digital video signals, particularly from a computer's video card to a monitor.
- It carries uncompressed digital video and can be configured to support multiple modes, including DVI-D (digital only), DVI-A (analog only), or DVI-I (digital and analog).
- The support for analog connections makes DVI backward compatible with VGA (Video Graphics Array).

- DVI's digital video transmission format is based on *PanelLink*, a high-speed serial link technology using *transition minimized differential signaling* (TMDS).
- Through DVI, a source, e.g., video card, can read the display's *extended display identification data* (EDID), which contains the display's identification, color characteristics, and table of supported video modes.
- When a source and a display are connected, the source first queries the display's capabilities by reading the monitor's EDID block.
- A preferred mode or native resolution can then be chosen.
- In a single-link mode, the maximum pixel clock frequency of DVI is 165MHz, which supports a maximum resolution of 2.75megapixels at the 60Hz refresh rate.
- This allows a maximum 16:9 screen resolution of 1,920×1,080 at 60 Hz.

High-Definition Multimedia Interface (HDMI)

- HDMI is a newer digital audio/video interface developed to be backward-compatible with DVI.
- Its electrical specifications, in terms of TMDS and VESA/DDC links, are identical to those of DVI.
- HDMI, however, differs from DVI in the following aspects:
  - HDMI does not carry analog signal and hence is not compatible with VGA.
  - DVI is limited to the RGB color range (0–255). HDMI supports both RGB and YUV 4:4:4 or 4:2:2. The latter are more common in application fields other than computer graphics.
  - HDMI supports digital audio, in addition to digital video.
- The maximum pixel clock rate for HDMI 1.0 is 165MHz, HDMI 1.3 increases that to 340MHz while the latest HDMI 2.0 supports 4K resolution at 60 fps.

DisplayPort

- DisplayPort is the first display interface that uses packetized data transmission, like the Internet or Ethernet.
- Specifically, it is based on small data packets known as *micro packets*, which can embed the clock signal within the data stream.
- DisplayPort can achieve a higher resolution yet with fewer pins than the previous technologies.
- The use of data packets also allows DisplayPort to be extensible.
- DisplayPort can be used to transmit audio and video simultaneously, or either of them.
- It has a much higher video bandwidth, enough for four simultaneous 1080P 60Hz displays, or 4K video at 60 Hz.

- Compared with HDMI, DisplayPort has slightly more bandwidth, which also accommodates multiple streams of audio and video to separate devices.
- It is royalty-free, while HDMI charges an annual fee to manufacturers. These points make DisplayPort a strong competitor to HDMI in the consumer electronics market